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PROSPECTS FOR NUCLEAR ENERGY IN BRAZIL

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ABSTRACT

One of the main purposes of nuclear technology is to produce electricity, with the advantage of producing a lower volume of radioactive waste. The expansion of nuclear energy in the electrical system has been positive, as it is one of the types of energy that is available at any time and in the desired amount. Considered a reliable source and safe alternative to compose a country's energy matrix. In the case of Brazil, it has enough reserves of Uranium and Thorium to compose the energy matrix over many years. The increase in demand, and the need for energy from renewable sources has caused changes in the world's electric power generation. According to World Nuclear Association (WNA), 14% of the energy is generated by nuclear energy sources, and this percentage tends to increase with the construction of new plants. According to the International Atomic Energy Agency (IAEA), the goal for nuclear energy is to provide 25% of electricity in 2050. Other technologies are applied in the nuclear area, for example nuclear medicine, in which radioactive materials are used with low doses of radiation for treatment and diagnosis of diseases, even in development are effective and safe, especially in the areas of cardiological, neurological and oncological diagnosis. Despite the knowledge acquired with the development of Brazilian nuclear projects, many are partly lost and discontinuity investments of successive governments, therefore, this work intends to study an overview of nuclear energy in Brazil in recent years and its prospects.

1. INTRODUCTION

Nuclear energy refers to the energy consumed or produced by the modification of the composition of atomic nuclei. It is seen by many as a source of clean and cheap energy, however the potential risk in the operation of nuclear reactors is represented by the high radioactivity of fission products and their release into the environment. Others feel that it may not be a viable alternative energy for the use of fossil fuel or solar energy.

One of the main purposes of nuclear technology is to produce electricity, which has the advantage of not using fossil fuels responsible for the emission of gases that cause the rise of global warming and other toxic products. Another advantage is that nuclear power plants do not need extensive areas, they can be installed in areas near consumer centers and are not influenced by climatic factors (rain, wind, etc.) for the development of their activities.

Nuclear fuel is all material that has been adapted to be applied in nuclear power generation. The fuel material is the fundamental constituent of nuclear reactors, where in these, energy is produced through the most widely used process known as nuclear fission. The material commonly used in fission reaction is the ^{235}U which in turn generates moderate chain reactions within the reactors.

According to World Nuclear Association (WNA), today, 14% of the world's electricity is generated through a nuclear source and this percentage tends to grow with the construction of new plants, especially in developing countries (China, India, Kazakhstan and others). The United States, which has the world's largest nuclear power plant with 104 power plants in operation, is expanding generation capacity and extending the service life of several of its plants. France, with 58 reactors, and Japan with 50, are also major producers of nuclear power, followed by Russia with 33 and South Korea with 21.

With the increasing demand for energy on the planet, different sources of power generation are applied in the global energy matrix, in order to ensure energy security in the countries, the major concern of the organizations are the obstacles and limitations to this expansion necessary, economic, security and environment, make policies are established to ensure compliance with this demand.

Organizations traditionally founded and structured with nuclear energy matrix, are re-evaluating new opportunities and constructive aspects, in order to increase security in this type of generation, especially after the terrible accident of Chernobyl and Fukushima, facts these staged and promoted technological change, especially in nuclear reactors Generation II, which is the type of nuclear reactor as used in the world.

In the search for energy security, the option of some countries for the generation of nuclear energy, which is produced with the alteration of the composition of atomic nuclei, stands out, the greater application of this phenomenon is destined for electricity generation, but there are other uses as production radioactive drugs and sensitive artefacts. For its main application, the generation of electric energy, several aspects are extremely relevant, is considered a source of clean and cheap energy production, but because its source is radioactive there is a risk of nuclear accidents that can have their origin through of natural phenomena, tsunamis and earthquakes (Fukushima accident), and also by human interference or error (Chernobyl accident), which can expose the population to levels of radiation that are fatal to humans.

2. NUCLEAR SAFETY

Aspects of safety with technological advances, are determinant for the growth of nuclear power world, with growing concern about energy shortages, rising cost of electricity and emission of greenhouse gases, several organizations have redirected their plans in order to guarantee the energy security of this system, a crucial element in establishing a relationship of trust in the face of the uncertainties already witnessed.

Accidents at the Three Miles Island, Chernobyl and Fukushima Power Plants should always remind operators of nuclear power reactors, their legislators, politicians and society that mismanagement or misconduct, corruption or spurious interference such as false information may cause accidents which take proportions out of common standards.

In order to avoid such issues, the International Atomic Energy Agency has an international program with several participating nations, including Brazil, where it determines what studies and reports are prepared on the Safety of a Nuclear Power Plant, and complex, and needing to achieve in Nuclear Risk Management one of the largest technological security, has elaborated Convention to have in the licensing of Nuclear Plants and Facilities the execution of a set of safety studies that should include: Nuclear Risk Analysis, Technological Conventional Risk Analysis, Deterministic Security and Emergency Action Plan.

Most of today's nuclear power plants were originally designed for 30 or 40 years of operational life. However, with major investments in systems, structures, component lifetimes can be extended, and in several countries, there are active programs to extend operational life. In the United States, more than one hundred reactors are expected to obtain license extensions ranging from 40 to 60 years. This implies significant investments in the modernization of systems and components, including the construction of extra performance margins.

Some components simply wear out, corrode or degrade and begin to operate at a low level of efficiency. These need to be replaced. Steam generators are the most prominent and expensive examples, and many have been replaced after about 30 years, but the reactor otherwise has the prospect of operating for 60 years. This is essentially an economic decision. Smaller components are simpler to replace as they get older. In CANDU reactors, pressure tube replacement was performed in some plants after about 30 years of operation. A second issue is obsolescence. For example, older reactors have analogic instruments and control systems. Third, the properties of materials can degrade with age, particularly with heat and neutron irradiation.

About all these aspects, the investment is necessary to maintain reliability and safety. In addition, periodic safety assessments are carried out on older installations in accordance with international safety conventions and principles, in order to ensure that safety margins are maintained.

Another important issue is knowledge management throughout the lifecycle, from design to construction and operation to decommissioning of reactors and other facilities. This can last a century, involve multiple countries, and involve a succession of companies. The plant's life span will span several generations of engineers. The data must be transferable through various generations of Informatic Technology-IT software and hardware, as well as be shared with other similar plant operators. Significant modifications can be made to the project over the life of the plant, so the original documentation is not enough, and the loss of project-based knowledge can have huge implications. Knowledge management is often a shared responsibility and is essential for effective decision making and for the safety and economy of the plant.

3. ENVIRONMENT AND NUCLEAR ENERGY

The Brazilian electricity matrix stands out from other countries for a reason, it is made up of 81.4% of renewable energy and nuclear energy is represented at about 2.5% in 2017 [1]. Brazil, therefore, has a great opportunity to become one of the world leaders in the energy sector. In order to be able to stay ahead, resources will be needed, maintenance of current

systems, modernization of systems, and especially investments in the research and development sector [2].

One of the major concerns today is the emissions of polluting gases that can increase the greenhouse effect and consequently the climatic changes that affect the terrestrial planet. One of the greenhouse gases is CO2 and a positive side of a nuclear power plant is that it does not emit this gas but is emitted permanently at all stages of the nuclear fuel cycle, from uranium oxide mining to the manufacture of fuel elements [3].

Nuclear Plants such as Angra dos Reis are equipped with a primary circuit without radionuclide leakage into the environment and the likelihood of a serious level accident occurring is minimal but not negligible. These plants are equipped with pressurized light water reactors (PWR) and the fuel elements are inside a pressure vessel, which is isolated from the environment by two envelopes, an internal steel vanadium and an external one that is concrete armed. A layer of air remains between these two shells at a pressure lower than atmospheric, and thus, if there are failures in the pressure vessel and in the inner envelope, possible leaks will be absorbed before reaching the outside [3].

The accidents that occur in nuclear power plants have enormous dimensions, because they propagate in space and time. The nearby regions can be contaminated and thus the local population should be evacuated, and the regions forbidden. A few years after the accident hundreds of people will suffer from evils induced by exposure to ionizing radiation, as is the case for populations that have remained close to Chernobyl [3]. These accidents should be avoided with increasing nuclear safety, reliable designs and systems, seeking to reduce the chances of failure and future accidents.

These improvements are introduced in older reactors. The requirements in all countries of the world are given through international agreements, managed by the International Atomic Energy Agency (IAEA). In Brazil, this control is the responsibility of the National Nuclear Energy Commission (CNEN), which performs the license part and inspects the facilities that use nuclear material in all areas, to ensure that the use is carried out within the safety standards [4].

Brazil has favourable conditions for expansion of construction of nuclear power plants such as Angra's in Rio de Janeiro, as it has a good area for mining in the north of the country. The Brazilian government has a project in phase of environmental licensing for a reserve, Santa Quitéria, located in Ceará, which has uranium associated with phosphate, which is of great importance to produce agricultural fertilizers [5, 6].

4. NUCLEAR MEDICINE

In nuclear medicine is used radioactive materials with low doses of radiation used for the treatment and diagnosis of diseases. The new technologies still in development are effective and safe, mainly in the areas of cardiological, neurological and cancer diagnosis. In order to obtain these images, this material are injected emitting gamma rays in the patient, which accumulate in a certain organ of the body.

One of the first applications was to generate images of the thyroid gland, for which iodine-131 has a short half-life (8 days) and is therefore less damaging to the patient's body. Iodine-

131 is ingested orally. There is a high emission of beta particles, which do not contribute to the diagnosis and that causes absorption of a high dose of radiation. Some of the most interesting developments in the generation of images for medicine have occurred in the field of tomography, which allows the formation of images of a specific part of the body, both through the external incidence of X-rays, as well as intravenous injection or radioisotope.

There is also axial computed tomography (CAT), a technique in which the incidence of X-ray bundles from various directions in the region of interest occurs. For each beam it is possible to determine the loss of intensity and, therefore, the level of absorption in a given direction. Thus, two-dimensional images of the region of interest can be formed. Another example is positron emission tomography (PET), in which a positron-emitting isotope is introduced into the area to be studied. Its decay allows the formation of images, in several aspects more interesting than those produced by CAT, since PET can also reveal dynamic effects, such as blood flow. Interesting applications for functional brain mapping are possible by this means.

PET uses cyclotrons, which have a very short half-life compared to radiopharmaceuticals. Cyclotron is an accelerator that produces a large amount of protons and sets them in motion along a circular orbit in a chamber with an alternating electromagnetic field, so that, by accumulating energy, they are thrown at a target with a velocity close to that of light. This target is the atom you want to change. The altered atom is the radioisotope to be used, which, in this case, must have the property of emitting positrons (β + decay), which are antiparticles of the electrons, when they decay, have short half-life (stability period) and be readily incorporated into a useful radiopharmaceutical through chemical synthesis.

The newest development in this area is nuclear magnetic resonance imaging (NMR). A sample is simultaneously exposed to a static magnetic field and to a radio frequency field varying in time, perpendicular to the static field. The NMR imaging technique has an advantage over the techniques of X-rays, gamma rays and positron emission, since the patient is not exposed to ionizing radiation; it is believed that the direct effects of static and variable magnetic fields on the body are insignificant.
The basic use of nuclear radiation in therapy is for the destruction of undesirable and undesirable body tissues of cancerous tumours. This is done with the ionizing abilities of nuclear radiation. In essence, the destruction of these tissues is done by the following steps: the incident radiation ionizes atoms of molecules of the irradiated material; the ionized molecules participate in a chemical reaction, which gives rise to free radicals or other excited molecules; and these free radicals can be incorporated into a complex biological structure (at the molecular level) and alter their functions, and it may take hours and even years for the effects of this biological change to become apparent.

CONCLUSIONS

It´s possible to conclude from this small study that nuclear energy is useful and welcome in its peaceful use, since its application is now being extended in many other areas with great benefits for man.

Unfortunately, when working with this type of energy, all kinds of safety precautions should be exhausted, as this cost will be paid in the future with the sale of energy and other products, which would have been extremely cheap, in the case of omission and breaking of

rules, we will have the loss of life and deterioration of the environment where the nuclear power plant is allocated, that is, it was very expensive.

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